VAMWA Perspectives
James River CHLa Criteria Study
Regulatory Advisory Panel Meeting

August 10, 2016

- Background perspectives
- Criteria magnitude and expression
- Criteria assessment
- Modeling

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Background perspectives

Factors considered when adopting water quality standards

- Support of designated uses
- Reasonable
- Practical
- Most scientifically defensible
- Availability of state resources
- Realistic
- Effect on business
- State employment rates
- Benefits and costs
- Provide more accurate assessments

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- Water quality criteria drive multi-billion dollar investments in nutrient reduction

- Linkages between CHLa and designated uses are especially complex

- It's important to "get it right" on the James for the environment and rate payers

The Commonwealth views the draft nutrient allocations included in EPA's July 1, 2010 letter for the James River basin to be at the lower end of a range of nutrient loads allocations needed to protect the aquatic life uses in the tidal James River. The Commonwealth concludes that <u>additional scientific study is needed</u> to provide a more precise and scientifically defensible basis for setting the final nutrient allocations.
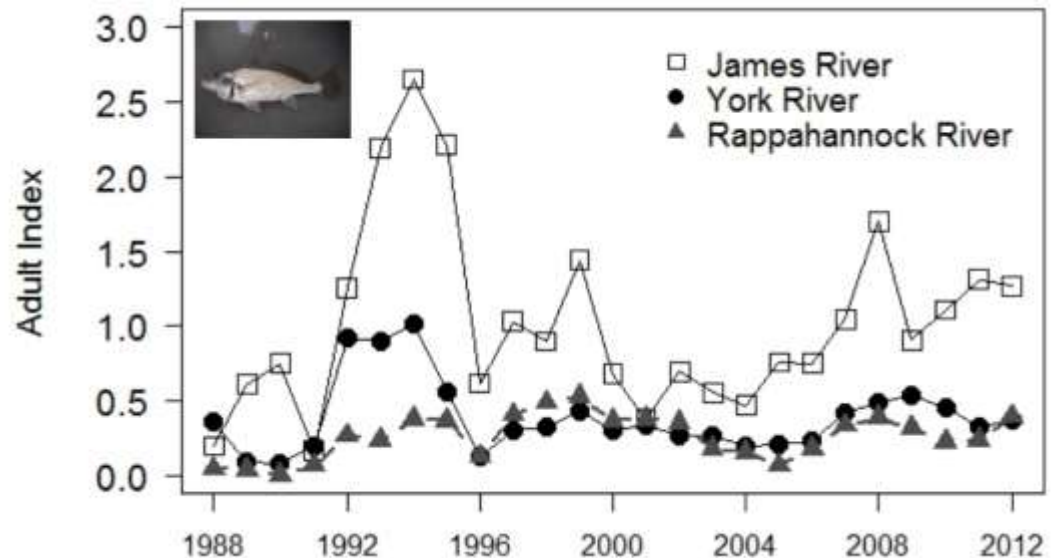
Phase 1 WIP

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- ## James is a highly productive fishery
  - Sport fish (e.g., catfish, largemouth bass)
  - Economically important species (e.g., perch, croaker)
- ## Positive signs for sturgeon
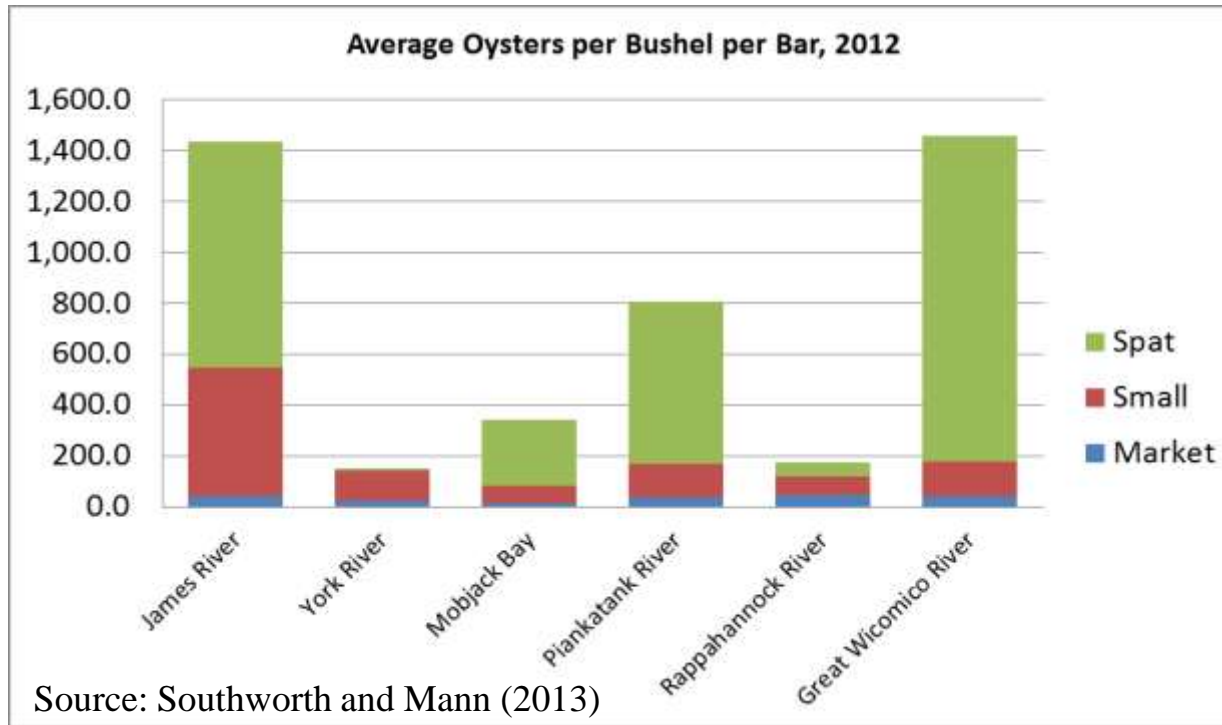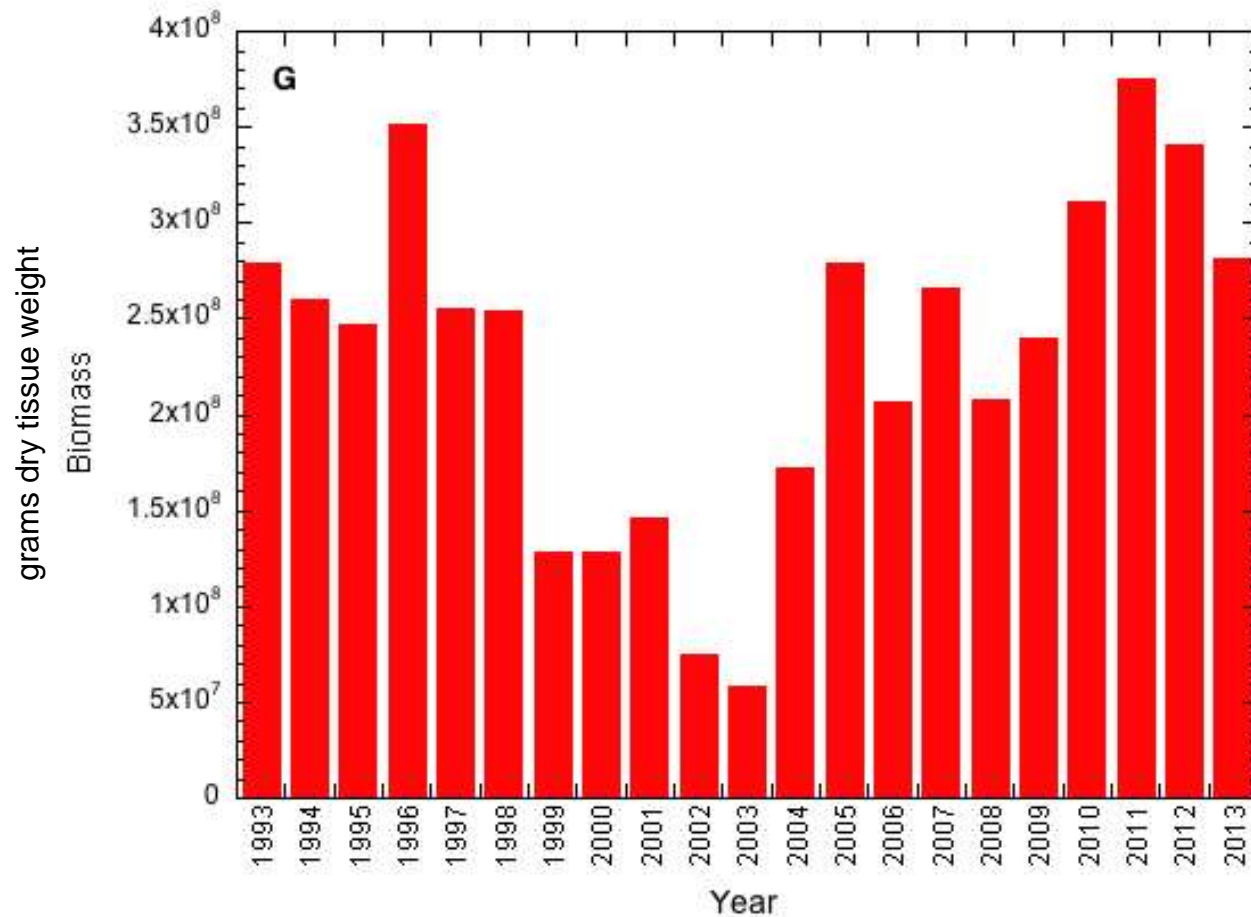 - Juveniles, evidence of spawning

Atlantic Croaker

Source: Tuckey and Fabrizio (2013)

Lower James River oyster status

Average Oysters per Bushel per Bar, 2012

Source: Southworth and Mann (2013)

- Oysters low Baywide compared to historical values
- Oysters increasing statewide since ~2006
- James River has good oyster status relative to major tributaries

# Historical Trend in James River Oyster Biomass

Source: VIMS (2014)

- "The James River…remains as the only river of note in Virginia that has supported and continues to support a commercial public fishery. Modest harvests are periodically taken from other rivers, but these are both inconsistent and small in volume compared with the James River harvests."

    -Mann and others (2009)

Benthic Macroinvertebrates Likely Affected by Legacy Contamination
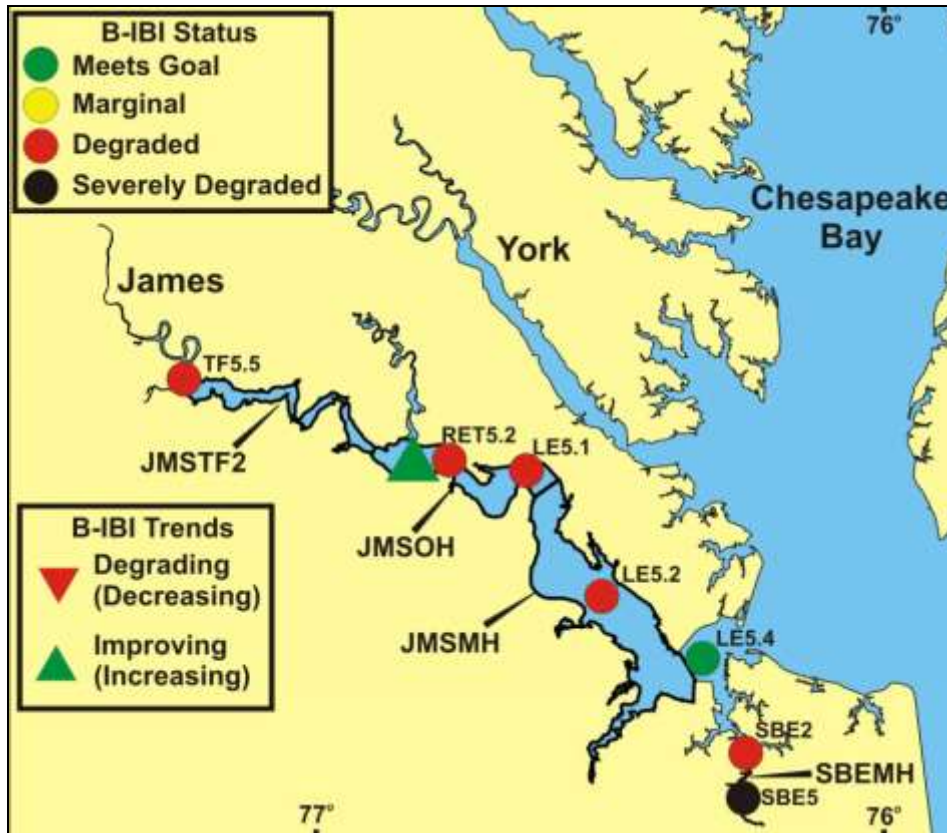

Source: Dauer and others (2012)

"…anthropogenic contaminants are identified as the predominant source of stress to the benthos while eutrophication and low dissolved oxygen do not appear to be a substantial problem."

-Dauer and others (2005)

- Biological resources of entire Bay system (including James) require additional recovery to reach historical status.

- **James appears to be most productive fishery of Virginia's major tributaries.**

- Ancillary information for informing the degree to which James CHLa conditions affect aquatic life uses.
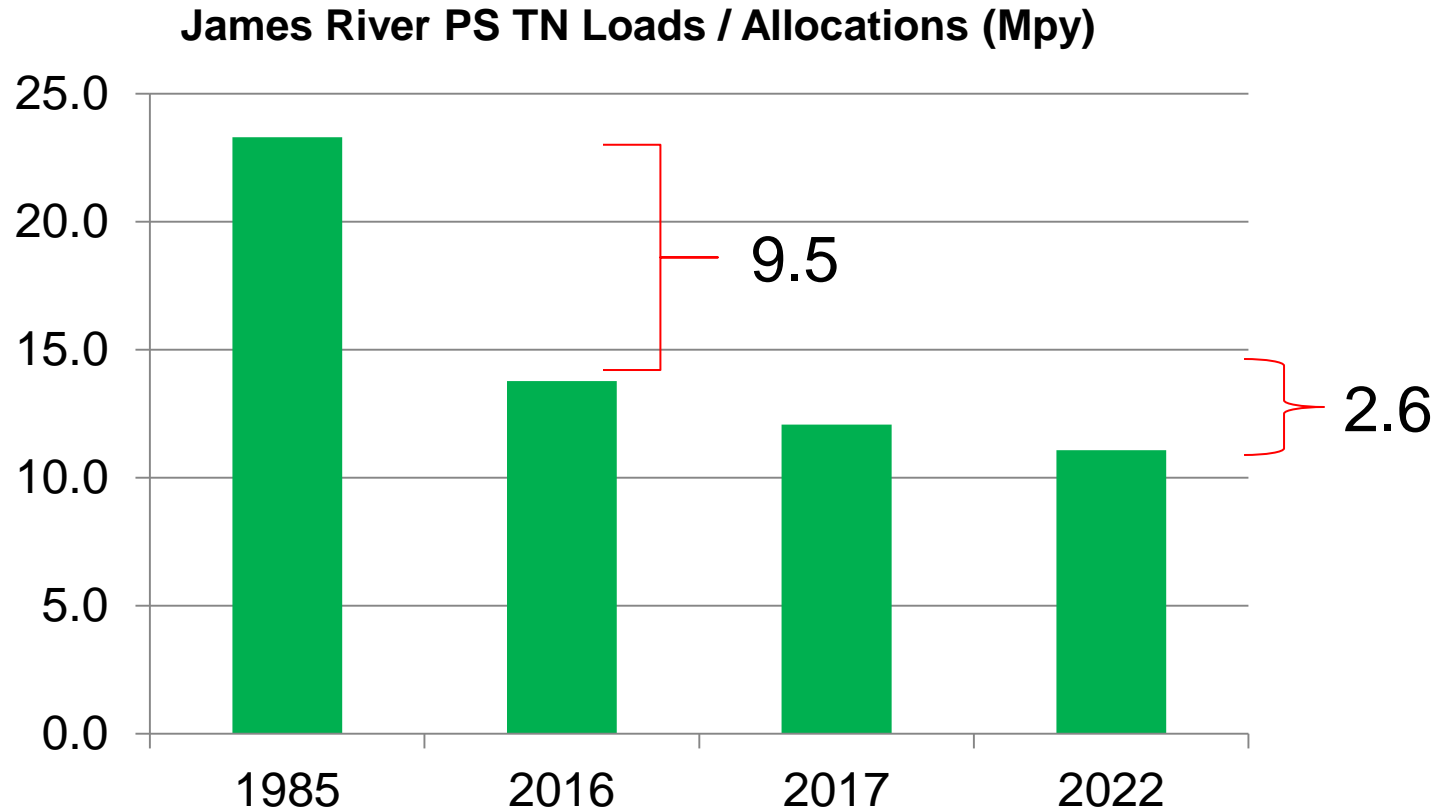
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Nutrient reduction: past, present, and future requirements

James River PS TN Loads / Allocations (Mpy)

Notes: 2016-2022 from 2016 VNCEA Exchange Report
1985 base-line from 2005 James Tributary Strategy pp. 38
2022 is main bay DO allocation

Nutrient reduction: past, present, and future requirements
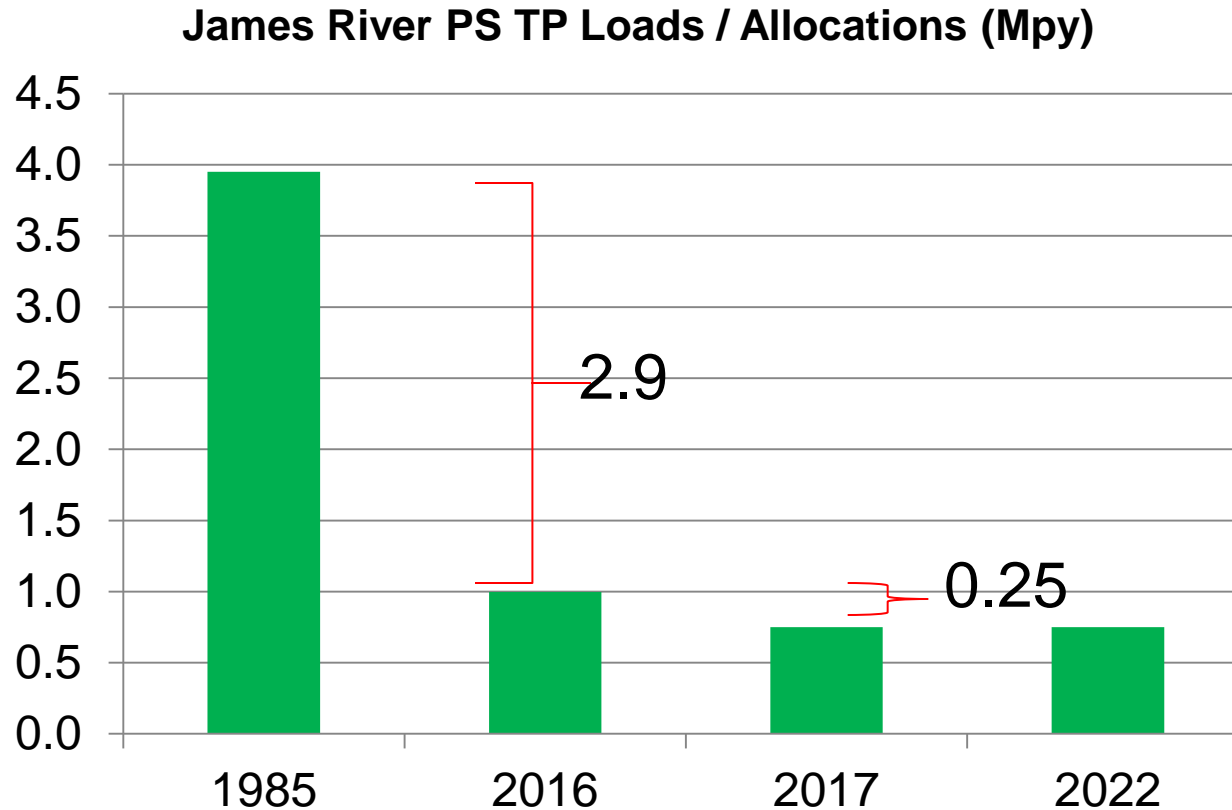
James River PS TP Loads / Allocations (Mpy)

Notes: 2016-2022 from 2016 VNCEA Exchange Report
1985 base-line from 2005 James Tributary Strategy pp. 38
2022 is main bay DO allocation

Criteria magnitude and expression

VAMWA preferred characteristics of CHLa criteria

- Effects-based

- Linked to actual designated use attainment, rather than statistical differences in metrics

- Not redundant with other water quality criteria

- Realistic and practical for the system of interest

Benefits:

- Better application of latest science

- Greater transparency in basis of criteria

- More defensible link to management decisions

Support for combined probability approach

The combined probability approach in ERR represents a significant advancement over past efforts

- Primarily <u>effects-based</u>
- Incorporates a great deal of new <u>James-specific data</u> and <u>experimental results</u>
- Also uses wider span of literature
- Significant advancement in linkages to <u>harmful algal effects</u>
  - *Cocholodinium*
  - *Microcystis*
  - Microcystin
- Results in a segment / season average criteria that supports a management and modeling framework

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Some ERR metrics are considered better than others

ERR metrics vary in their linkage to designated uses

<u>Most useful metrics</u> (good linkages with uses)
- HABs- Microcystin and *Cochlodinium*
- pH

<u>Metrics with questionable / indirect linkages to uses</u>
- PIBI – Based on reference condition, highly dependent on water clarity, impairment not reliably predictable
- Percent algal contribution to TSS – Not a direct measure of water clarity, James water clarity is generally insensitive to CHLa at the ranges being considered
- DO- James does not have a significant DO problem and responses can be modeled independently of CHLA criteria

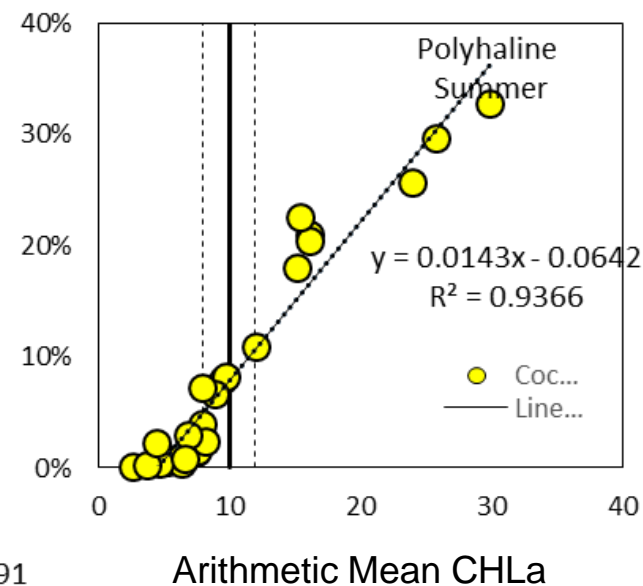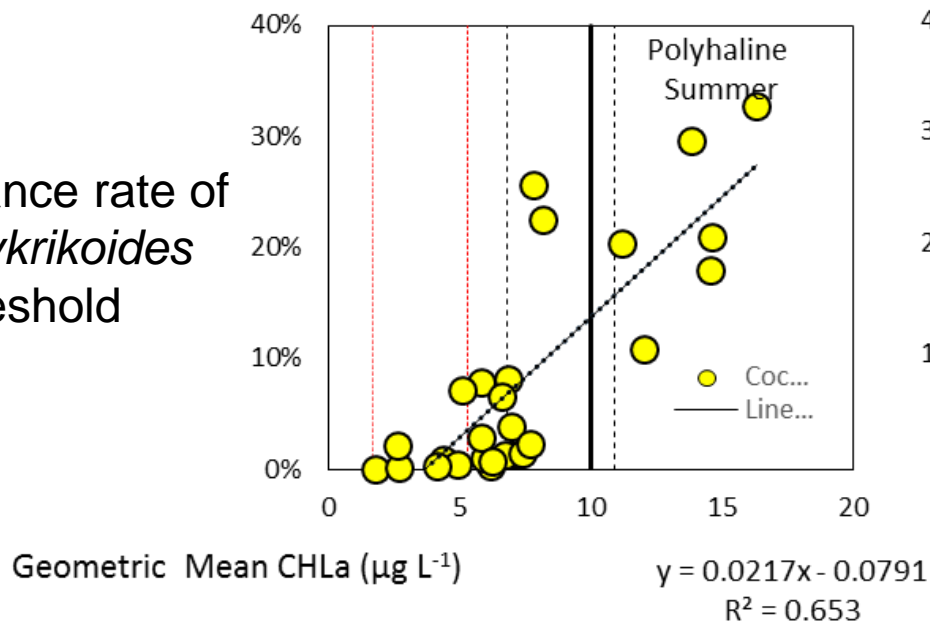| Table 1. Summary of Review of Target CHLa Ranges for Management												
	Spring						Summer					
James River Segment	Existing CHLa Criteria (ug/L)	Protective Range (ug/L)	Review Opinion	Recommended Protective Range (ug/L)	Upper End of Range Informed by Antideg.	Comment	Existing CHLa Criteria (ug/L)	Protective Range (ug/L)	Review Opinion	Recommended Protective Range (ug/L)	Upper End of Range Informed by Antideg.	Comment
Tidal Fresh Upper	10	None	Agree	N/A	N/A	1	15	<12-21	Agree; alt. range also recommended	<12-40	Yes	6
Tidal Fresh Lower	15	<10-16; 16-19	Agree with 16-19	<10-19	No	2	23	<27-31; 32-43	Agree with 32-43	<27-43	No	7
Oligohaline	15	<7-18	Agree	N/A	Yes	3	22	None	Agree	N/A	N/A	8
Mesohaline	12	<13-21	Adjustments recommended	<13-22	Yes	4	10	<8-13	Agree	N/A	No	9
Polyhaline	12	<7-11	Adjustments recommended	<7-15	Yes	5	10	8-12	Agree	N/A	No	10

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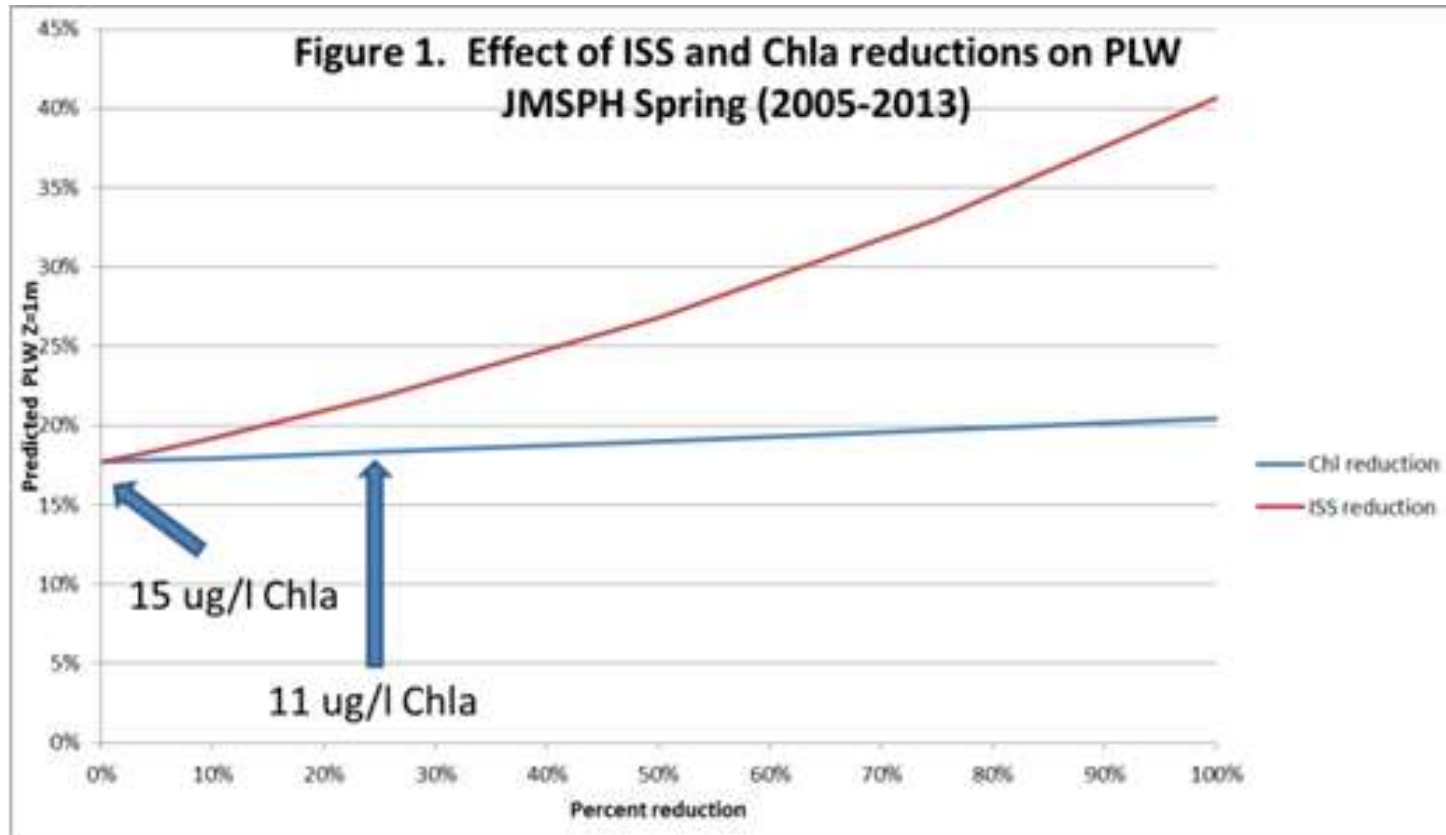
Note: Assumed starting concentrations= 12 mg/l ISS, 15 ug/l Chla

- Arithmetic mean vs geometric mean
  - Better correspondence between effects and CHLa with arithmetic means than observed geometric means (especially in the lower estuary)

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Arithmetic Mean Superior for Predicting CHLa-related Effects

Exceedance rate of *C. polykrikoides* threshold

Geometric Mean CHLa (µg L^{-1})

$y = 0.0217x - 0.0791$
$R^2 = 0.653$

Arithmetic Mean CHLa

$y = 0.0143x - 0.0642$
$R^2 = 0.9366$
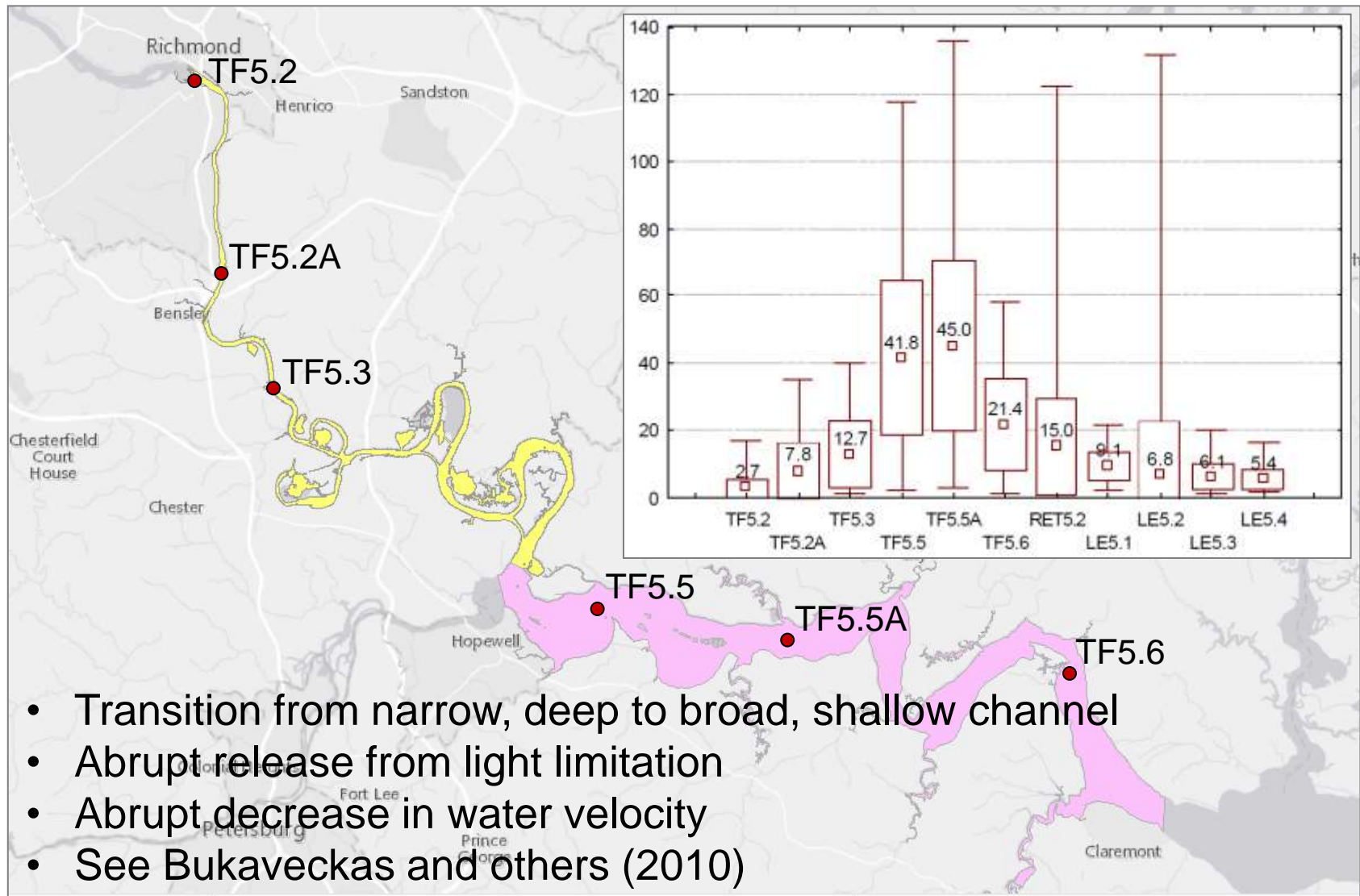
Data source: CBF (2016)

- Another approach: Consider mapping the arithmetic mean to geometric mean using James River specific data

- Results in similar responses as arithmetic mean (i.e. preserves bloom effects)

  - Comparable to Peter Tango's suggestion but uses site specific rather than Bay wide data

Criteria Assessment

- Absence of an accepted biological reference

- Tends to be overly stringent

- High variability (pass/fail) across assessment periods reduces certainty of management decisions

- **Concur with VADEQ's proposed alternative approach** – it is consistent with other States (e.g., FL, MN)

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- Transition from narrow, deep to broad, shallow channel
- Abrupt release from light limitation
- Abrupt decrease in water velocity
- See Bukaveckas and others (2010)

Lower James bloom dynamics (2014 vs 2015)

Figure 2. Temperature-salinity diagram of dinoflagellate blooms (>10³ cells mL⁻¹) in James River during 2014 and 2015.
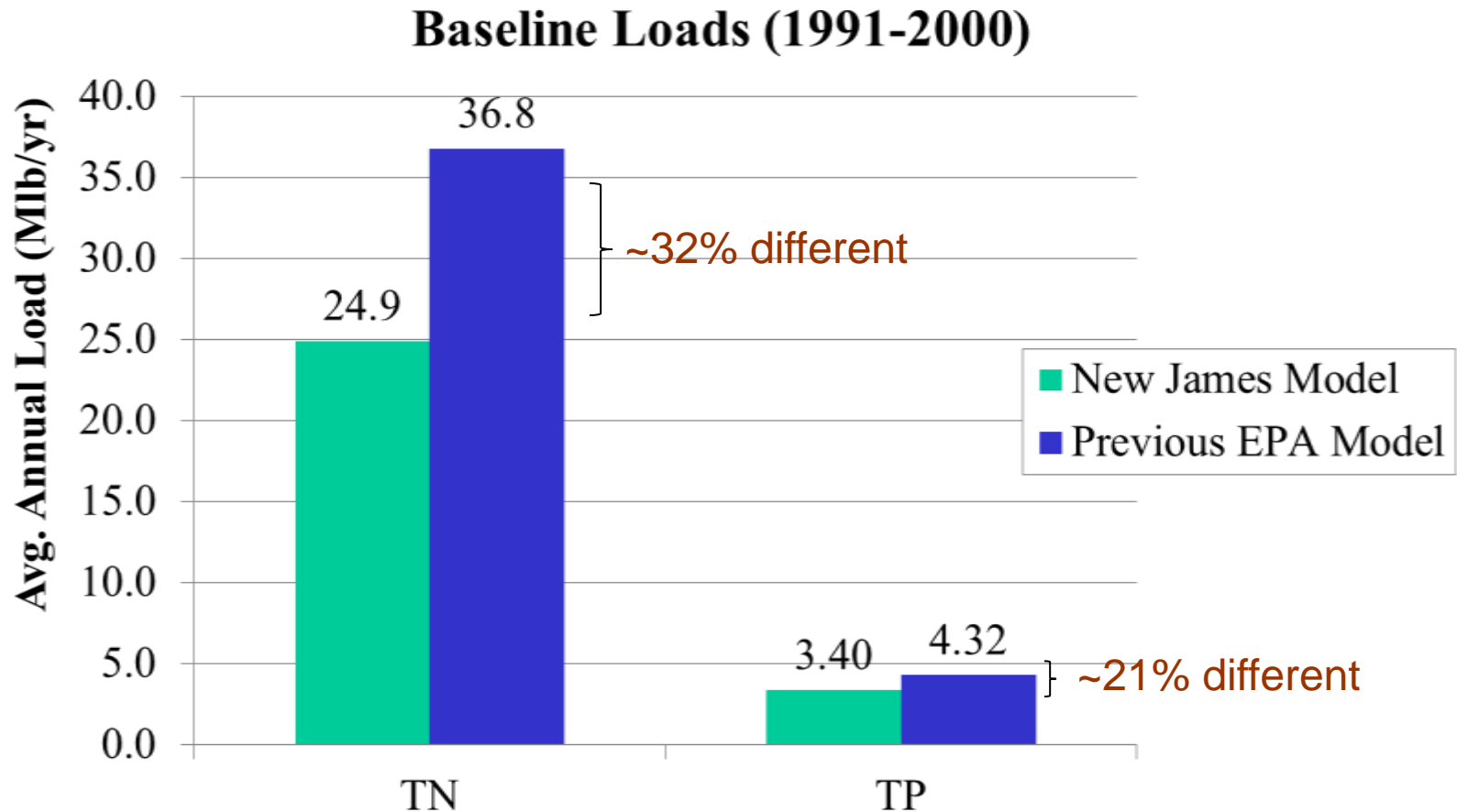
Source: Echevarria (2016)
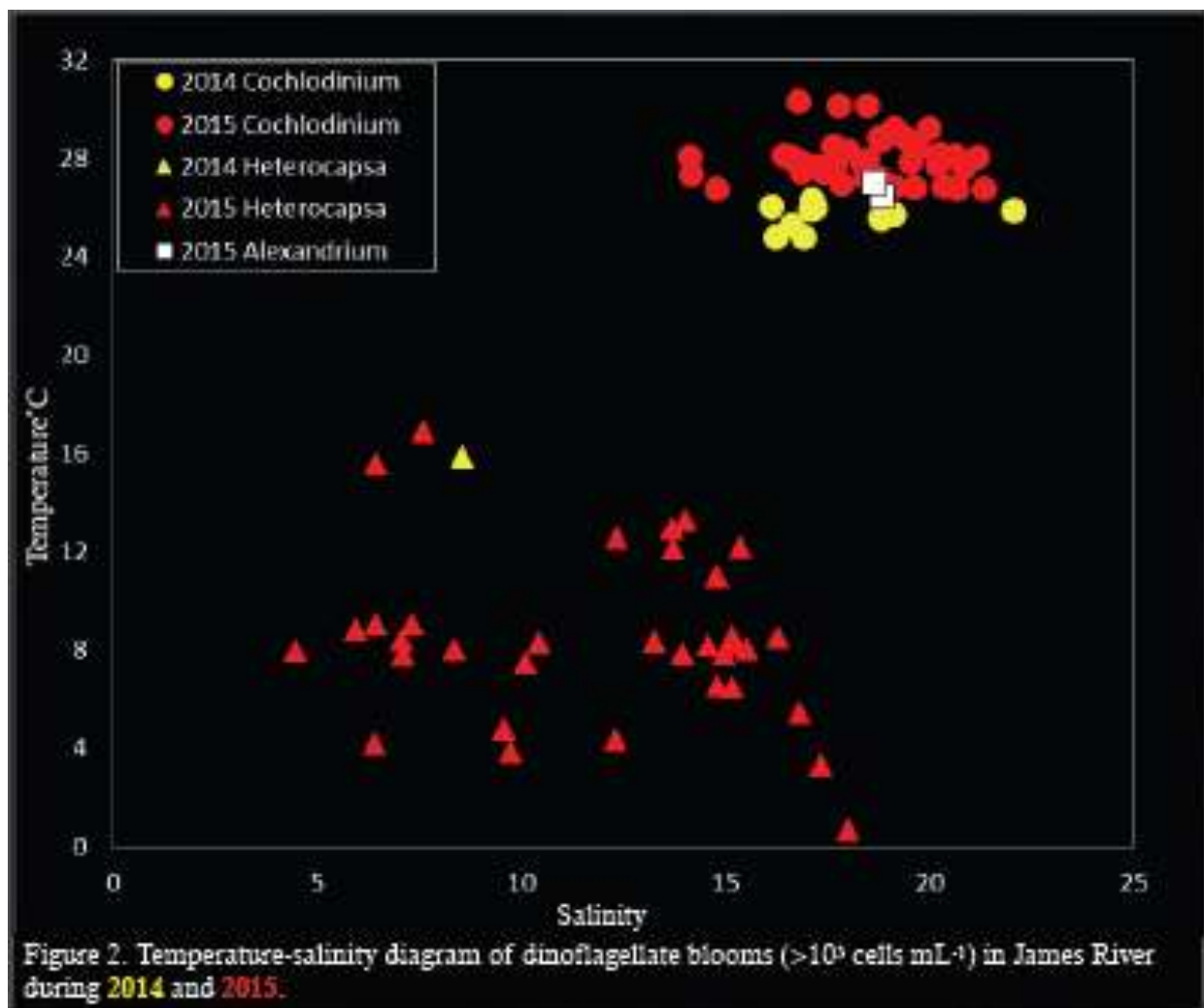
CHLa criteria / nutrient controls not expected to eliminate taxa such as *Microcystis* or *Cocholodinium*

- ## Cyanobacteria
  - Natural minority component of the (diatom-dominated) tidal freshwater community
  - Favored by lower light conditions, which are predicted to persist due to resuspension
- ## *Cochlodinium polykrikoides*
  - Prevalence partly due to transport in ballast water (Tang and Gobler, 2012)
  - Can out-compete other taxa for nutrients (Kudela and Gobler, 2012)
  - Does not require eutrophic conditions to bloom (Gobler, 2010)
  - Favored by complex conditions (Mulholland and others, 2009)

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- Nutrient reductions will not eliminate blooms

- Need to set allowable exceedence rates given natural/uncontrollable factors

- Concur with DEQ that 2/6 year allowable exceedance addresses unique characteristics of the James River while providing more responsible management decisions

- Adaptive management must play a role in the plan to meet designated uses

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Modeling

Baseline Loads (1991-2000)

New James model vs current EPA model

Attainment Predictions - Spring Season

Load Reduction Scenario and Year Range Correspondence		Spring Seasonal Assessment of Compliance with Chl-a Water Quality Standards									
		JMSTFU		JMSTFL		JMSOH		JMSMH		JMSPH	
VADEQ Scenario	Year	CBP Model	VIMS SEM	CBP TMDL	VIMS SEM	CBP Model	VIMS SEM	CBP Model	VIMS SEM	CBP Model	VIMS SEM
2010 TMDL	'91-'93	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	26.8%	0.0%	0.0%
	'92-'94	0.0%	8.4%	0.0%	0.0%	0.0%	0.0%	0.0%	9.0%	0.0%	0.0%
	'93-'95	0.0%	8.4%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	'94-'96	0.0%	8.4%	0.4%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	15.0%
	'95-'97	0.0%	0.5%	0.4%	4.4%	0.1%	0.0%	0.0%	1.8%	0.0%	15.0%
	'96-'98	0.0%	0.5%	0.0%	4.4%	0.1%	0.0%	0.0%	1.8%	0.0%	15.0%
	'97-'99	0.0%	0.5%	0.0%	4.4%	0.0%	0.0%	0.0%	13.3%	0.0%	0.0%
	'98-'00	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.1%	0.0%	0.0%
DO Attainment	'91-'93	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.6%	31.3%	0.0%	0.0%
	'92-'94	0.0%	11.0%	0.0%	0.0%	0.0%	0.0%	0.7%	9.6%	0.0%	0.0%
	'93-'95	0.0%	11.0%	2.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	'94-'96	0.0%	14.3%	2.1%	0.0%	3.8%	0.0%	0.0%	0.0%	0.0%	18.4%
	'95-'97	0.0%	5.4%	2.1%	5.1%	3.8%	0.0%	0.0%	2.7%	0.0%	18.4%
	'96-'98	0.0%	5.4%	0.0%	5.1%	3.8%	0.0%	0.0%	2.7%	0.0%	18.4%
	'97-'99	0.0%	2.2%	0.0%	5.1%	0.0%	0.0%	0.0%	14.8%	0.0%	0.0%
	'98-'00	0.0%	1.6%	0.0%	0.0%	4.6%	1.5%	0.0%	9.9%	0.0%	0.0%

Source: Scott Hinz, LimnoTech (2016)

Specific cases:

– Oligohaline spring 2008-10

– Mesohaline summer 2008-10, 2010-12

– Polyhaline summer, 2008-10, 2010-12

- Documentation of scenario assumptions are needed

- Response to comments has been received but modeling status is uncertain

- Will there be a revised model report?

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Near term:

- Use model in it's current form only to provide insights on load response
- Do not use James model to set allocations at this time.
- Evaluate load-response with SAP Chla criteria ranges and DEQ's proposed alternative assessment method

Longer term:

- Continue to consider new information as it develops
- Establish cooperative process to resolve modeling issues
- Consider roles of James and EPA models

- Three elements needed for standards proposal
  - Criteria revision
  - Replacement assessment method
  - Model that provides confidence in load-response
- These three must be accomplished together
- Current schedule (draft criteria proposal by Dec 2016) may not allow time to fully resolve modeling/load-response issues.

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